Patent Application

of

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for

Pivotal Body For Multi-Function Nozzles

CROSS-REFERENCE TO RELATED APPLICATIONS

This utility application claims priority from **U.S. Provisional application Ser. No. 60/431,681**, titled "Pivot Nozzle Body" filed on Dec. 7, 2002, and **U.S. Disclosure Document No. 483532**, filed on Dec. 7, 2000.

BACKGROUND-Field of Invention

The field of this invention relates to cleaning nozzles for use with vacuum cleaner hoses, and more specifically to the nozzle body that holds the nozzle tools for use.

BACKGROUND-Description of Prior Art

Ever since the vacuum cleaner hose was invented, vacuum nozzle attachments have

been around. Various types of vacuum tools of were invented to do specific cleaning functions. Soon it became apparent that for floor cleaning tools, and other vacuum tools, a pivot joint on the vacuum nozzle attachment made it more versatile. With a pivot joint one could rotated the nozzle to a specific angle for cleaning. For floor tools this allowed the vacuum tool to more easily follow the floor surface. This allowed the user to angle the hose wand to the floor to get under a low lying furniture while keeping the cleaning tool flush against the floor. For example, **U.S. Patent No. 1,104,148** to Spencer, and others like it, show a vacuum tool with a pivot joint to change the apparent angle between an inserted hose wand and the cleaning portion of the vacuum nozzle tool. No prior art was found which incorporated vacuum tool attachment points on both ends of the pivot joint. All prior art shows only one end of the pivot joint body being designed for attachment of vacuum nozzle tools. The presented invention provides vacuum nozzle attachment on both ends of the pivot joint. All prior art vacuum cleaner pivot adaptors provide one end for attachment of a vacuum cleaner hose wand, and the other end for attachment to a vacuum tool. For example, **U.S. Patent No. 6,581,974** to Ragner, and others like it, show a vacuum adaptor (or pivot body) with a pivot joint between its two ends: 1) a vacuum tool end, and 2) a vacuum hose wand end. No prior art was found that showed a vacuum pivot body with both ends being designed to accept both a vacuum tool and a vacuum hose wand at the same time and/or alternately. The ability to attach the hose wand to both ends of the pivot body is critical to the disclosed inventions application, as is, the ability to attach vacuum nozzles to both ends. Multi-function vacuum nozzles do exist, for example, **U.S. Patent No. 3,108,311** to House, and others like it, that are designed to provide both ends of the nozzle body with a hose wand port and a vacuum tool port. Also, additional ports have been demonstrated by the three port design shown in **U.S. Patent No. 5,502,870** to Ragner, where the nozzle body has two ports that accept a vacuum hose and two ports that have cleaning tools on them, with only one port that has both hose wand and vacuum tool attachment capabilities. None of these prior arts, however, suggest or show a pivot joint that would be beneficial for the operation of their device. The addition of a pivot joint on a two-ended multi-function vacuum tool, provides the desirable benefit of a pivot joint for both ends of the vacuum tool while only requiring a single pivot joint.

SUMMERY

When a vacuum nozzle is used for vacuuming a floor, the proper angle must be maintained with the contact surfaces to provide good cleaning contact with the floor. However, until now, multi-function nozzles with cleaning tools on both ends of the nozzle would have to maintain this contact angle by keeping the hose wand at a specific angle, usually about forty-five degrees with the floor. This severely restricts cleaning under low furniture where the fixed angle of the vacuum nozzle causes the nozzle's cleaning surface to lift off the floor when the attached hose wand is lowered to get under the furniture. Pivot joints are commonly placed on floor tools for this vary reason, however, multi-function tools that place tools on both ends have designed for use on floors, thus the use of a pivot joint to provide angle adjustment of the hose wand was not needed. It is only after the multi-function vacuum tool is designed for use on a floor, that one realizes the pivot joint is needed. The design of the pivot joint itself requires some additional thought to insure that both ends of the nozzle can function properly with the pivoting action between them. It turns out, in most cases that the pivot axis should be closer than 45 degrees from the **x-axis** as defined in **Figs. 1** through **7** by coordinate system **90**. The multi-function nozzle can be made even more stable by keeping the pivot axis closer than 30 degrees from the **x-axis**. Where the **x-axis** is defined in a right-handed Cartesian coordinate system, with the longitudinal direction of the upholstery tool aligned with the **y-axis**, and the **z-axis** perpendicular to the floor surface being cleaned.

OBJECTIVES AND ADVANTAGES OF THE INVENTION:

NOZZLE BODY

a) To provide a pivotal nozzle body with an attachment means on both ends for connecting a vacuum cleaning tool(s).
b) To provide a pivotal nozzle body with an attachment means on both ends for connecting a vacuum cleaner hose wand.
c) To provide a pivotal nozzle body with an attachment means on both ends for alternately connecting a vacuum cleaning tool and vacuum cleaner hose wand.
d) To provide a pivotal nozzle body with an attachment means one end for connecting a vacuum cleaning tool and a vacuum cleaner hose wand at the same time.

e) To provide a pivotal nozzle body with two ends each designed for attachment of a vacuum cleaning tool and a vacuum cleaner hose wand at the same time.

VACUUM NOZZLE

f) To provide a pivot nozzle comprising a pivotal nozzle body with a replaceable cleaning tool(s) on two ends of the nozzle's pivotal nozzle body.

g) To provide a pivot nozzle comprising a pivotal nozzle body with an integrated cleaning tool on one end of the nozzle's pivotal nozzle body and an attachment means on a second end of the nozzle's pivotal nozzle body for removably connecting a vacuum cleaning tool(s).

h) To provide a pivot nozzle comprising a pivotal nozzle body with an integrated cleaning tool(s) on two ends of the nozzle's pivotal nozzle body.

i) To provide a pivot nozzle comprising a pivotal nozzle body with a replaceable cleaning tool(s) and a hose wand port on each of the two ends of the pivotal nozzle body.

j) To provide a pivot nozzle comprising a pivotal nozzle body with a replaceable cleaning tool(s) and a hose wand port on one end of the pivotal nozzle body, and an integrated cleaning tool(s) and a hose wand port on the other end of the pivotal nozzle body.

k) To provide a pivot nozzle comprising a pivotal nozzle body with an integrated cleaning tool(s), and a hose wand port on each of the two ends of the pivotal nozzle body.

PIVOT JOINT

l) To provide a stable pivot joint for a two-ended multi-function vacuum tool when cleaning in different cleaning modes.

m) To provide a pivot joint with a built in friction that is sufficient for dusting mode, but small enough to allow easy pivoting when using in floor cleaning mode.

n) To provide a pivot joint with a pivot axis less than 30 degrees from the **x-axis** as defined in this patent.

o) To provide a pivot joint with a pivot axis less than 30 degrees from the **x-axis** as defined in this patent, and with the pivot axis having both **y-axis**, and **z-axis** components.

DRAWING FIGURES

Fig. 1 Pivotal nozzle body with pivotal arms on one end and a dust brush on the other.

Fig. 2 Pivot Nozzle in **Fig. 1** with upper housing rotated 180 degrees from its position in **Fig. 1**.

Fig. 3 Section view of Pivotal Nozzle Body in **Fig. 1** (hose wand away from **x-axis**)

Fig. 4 Section view of Pivotal Nozzle Body in **Fig. 1** (hose wand near **x-axis**)

Fig. 5 Section view of an alternative Pivotal Nozzle Body (lower housing **130** and upper housing **150**) with pivot axis angles θ_5 and θ_6 being different than θ_1 and θ_2.

Fig. 6 Perspective view of pivot nozzle in **Fig. 5** pivoted at approx. 90 degrees from the position shown in **Fig. 5** with hose wand connected to brush end.

Fig. 7 Perspective view of pivot nozzle in **Fig. 5** pivoted at approx. 90 degrees from the angle shown in **Fig. 5** with hose wand connected to pivot arm end.

DETAILED DESCRIPTION OF THE INVENTION

The disclosed pivotal nozzle body can be manufactured using any of a number of durable materials. For example, organic polymers, such as, ABS, Polypropylene, etc. are its preferred construction materials, but can also be constructed of other materials, such as, stamped or machined metals or composites. The tolerances for the disclosed pivotal nozzle body is well within the accuracy range for injection molded plastic parts, with components designed to snap together during the manufacturing process.

Figs. 1 through **4** show one example of a multi-function vacuum nozzle using a pivotal nozzle body comprising an upper housing **50** and a lower housing **30.** Upper housing **50** comprises a brush shroud **52,** a first tool end **55** on the brush shroud for connecting a dust brush **70**, a hose wand port **54** with air channel **56** therethrough, and a first pivot end **57** with air channel **59** (formed by pivot rings **37** and **57**) therethrough, for connecting to lower housing **30.** Lower housing **30** comprises a lower body section **32** with air channel **36** therethrough, a second tool end **34** for connecting arms **60**, and a second pivot end **37** for connecting to upper housing **50.** Air channels **36** and **56** also act as friction fit hose wand port connectors. Within the pivotal nozzle body, air channels **36**, **59** and **56** form a continuous air channel for

communicating suction air from one hose wand port to the opposite tool end. This continuous air channel allows a suction hose wand **20**, when inserted into air channel **56** (see **Figs. 1** through **6**), to provide suction air to second tool end **34** and arms **60.** This continuous air channel also allows suction hose wand **20**, when inserted in air channel **36** (see **Fig. 7**), to provide suction air to first tool end **55** and dust brush **70.**

Upper housing **50** defines an air passageway **56** which is designed to accept hose wand **20** as shown. Air channel **56** may be formed by a cylindrical tube **54** that is molded into upper housing **50**. Also on upper housing **50** is a upper tool support (or shroud) **52** with a dust brush connector (first tool end) **55** for supporting a dust brush **70**. For this design dust brush **70** has a metal U-channel support **72** which holds the bristles of the brush together. U-channel **72** fits snugly into outer lip of connector end (first tool end) **55** on brush shroud **52** to attach it to upper housing **50**. Tool end **55** can be a circular shaped, a tear drop shaped, a triangular shaped or nearly any shape to hold a dust brush or other tool of that shape. Other types of cleaning tools can be attached on tool connector **55**, if they have a matching connector style. Alternatively, tool connector end **55** can be modified to other connector styles if desired. In this way, the tool holder portion of housing **50** (shroud **52** and tool holder **55**) can be designed to accept other vacuum cleaning tools with a different connector style(s).

Lower housing **30** can be adapted to connect a variety of different vacuum tools at second tool end **34**. Arms **60** snap fit into two pairs of holes in connector **34** to provide a pivot axis in the x-axis direction to allow arms **60** to pivot between an in-line position (see **Fig. 6**) and a closed position (see **Fig. 7** for almost closed arms). This type of arm connector style is only one example of the nearly unlimited design possibilities for connector **34.** Air channel **36** within body section **32** and the arm connector (second tool end) **34** is designed so that vacuum hose **20** fits snugly into it (see **Fig. 7** for example on similar nozzle), when the arms are slightly spread apart. In **Figs. 1** through **4**, two arms **60** (other arm directly behind the one shown - view is looking at arm on end - see **Fig. 7** for example on similar position for nozzle arms **160**) are shown mounted on second tool end **34**. Second tool end **34** can be designed to provide pivotal attachment for arms **60** so they may pivot between a crevice tool position and an upholstery tool position. In upholstery position (and floor tool **Figs. 1** through **6**) the arms extend along the **y-axis** with edges **62** for making contact with a surface to be cleaned **68**. In the crevice tool mode

(see partial example in **Fig. 7**), arms **60** would rotate together so that U-channels **64** coming together to form an single elongated channel. Tool end **34** in **Figs. 1** through **4** comprise two flanges on each side of arms **60,** which can be molded directly into lower housing **30**. Lower housing **30** has a body section **32** with interior channel **36** which is designed to accept hose wand **20**, and communicate suction air through channel **36** and the rest of the pivotal nozzle body.

Lower housing **30** is attached to upper housing **50** at a pivot joint near the middle of the pivotal nozzle body (housings **30** and **50**). The pivot joint comprises a female ring shaped port **37** (second pivot end) with a locking lip **38** on lower housing **30,** and a male ring shaped tube **57** (first pivot end) with a locking groove **58** on upper housing **50**. A tube **57** has a groove **58** that interacts with groove **38** on ring **37** to hold housing **30** and **50** together. Ring **37** and tube **57** are designed to rotate about the pivotal nozzle body's pivot axis **40** and provide 360 degree pivotal action for the pivotal nozzle body (housings **30** and **50**). The direction of pivot axis **40** may be oriented in a number of possible directions and does not need to lie in the **x-z** plane as it does in **Figs. 1** through **7** (discussed further in these specifications). In general, the pivot axis should be within 45 degrees of the **x-axis**, however for specific purposes a greater angles can be better (i.e. for vacuum tools where a side-to-side motion is used). For use with upholstery tools or floor tools, using 45 degrees or less from the **x-axis** provides a reasonably stable tool, but 30 degrees or less is better. Angles from the **x-axis** of more than 45 degrees starts to make a floor tool or an upholstery tool unstable, and they tend to flop around on the end of the hose wand during use. Note that the terminology "within 45 degrees of the **x-axis**" refers to set of directions the pivot axis may lie on within a cone centered along the **x-axis**. This means the direction of the pivot axis **40** may be angled above or below the horizontal, and to the left and right (a directional component along the **y-axis**).

In **Fig. 3** we see that the pivot joint formed by ring **37** and tube **57,** has a length $\mathbf{L_1}$. This length $\mathbf{L_1}$ is rather short for this type of pivot axis, however, if hard plastics are used, this type of pivot joint can work smoothly. Most often pivot joints of this nature have a length of about one inch or more (see **Fig. 5** for example of a longer pivot joint). This helps keep the joint from binding against is own surfaces as additional forces try to twist it. Some friction is desirable for the pivot joint and may be provided by the surface contact between tube **57** of upper housing

50 and ring **37** of lower housing **30**. While very little friction is needed when the nozzle is being used as a floor tool, friction is needed for other functions of the nozzle, such as, when the dust brush **70** is being used or the arms are used as a crevice tool. This friction may also be created by one or more snap lock positions where the upper and lower housings click into a high friction position. These locking positions may be provided by a notch on one housing and a matching tab on the other housing. The tab (or tabs) would snap into the notch (or notches) as the upper and lower housings are rotated with respect to each other. These notches and tabs are not shown in the figures to keep the drawing more readable, but may be placed on any of the contacting surfaces between housings **30** and **50** to create the snap lock positions. These snap lock positions are designed to automatically release by applying more rotational force to the pivot joint to cause the tabs to slide pass the notches. Sufficient locking friction is provided to allow normal use of the tools on the nozzle, but still easily released with additional force to change its orientation.

For purposes of clarity, the disclosed pivot nozzles have their lower housings (i.e. housing **30** in **Figs. 1-4** and housing **130** in **Figs. 5-7**) oriented similarly with respect to a coordinate axis system **90** in all figures. Each drawing sheet includes an axis map **90**, which shows the direction of the **x**, **y** and **z-axis** for discussion drawings on that sheet to provide a right-hand coordinate system. The arrows marked **x**, **y**, **z** on axis system **90** each denote the **x-axis**, **y-axis** and **z-axis**, respectfully. In **Figs. 1** through **5**, the **y-axis** points directly into the page with the **x-axis** and **z-axis** in the plane of the paper. In **Figs. 6** and **7**, both the **x-axis** and **y-axis** are angled into the page with the **z-axis** in the plane of the paper. This coordinate system, with respect to **Figs. 1** through **7**, may be also used in the claims to define the pivot axis of the pivotal nozzle body (housings **30** and **50** in **Figs. 1-4** and housings **130** and **150** in **Figs. 5-7**). The lower housings (housings **30** and **130**) are oriented so that the cleaning edges **62** and brush strips **162** for the upholstery tool (see **Figs. 1-6**) align with the **x-y** plane and the pivot axis for the arms is substantially aligned with the **x-axis**. This position also allows arms **60** and **160**, to pivot downward to align in the negative **z-axis** direction for use as a crevice tool (see **Fig. 7** for partial example). This defines the **x-axis** as pointing in the direction of the upper housing (i.e. upper housing **50** in **Figs. 1-4** and housing **150** in **Figs. 5-7**) and parallel to the surfaces to be cleaned **68** and **168**, respectfully.

Axis angles θ_1 and θ_2 are defined by the structure of nozzle housings **30** and **50**, respectfully. Lower housing **30** defines angle θ_1 as generally the minimum angle between the rotational axis of second pivot end **37** and the plane defined by cleaning edges **62** (**x-y** plane, measured from the positive **x-axis** in drawings). Angle θ_1 can also be thought of as the angle between pivot axis **40** and the longitudinal axis of hose wand port **36** (negative z-axis) minus ninety degrees. Upper body housing **50** defines angle θ_2 as the angle between the axis of first pivot end **57** and the longitudinal axis of hose wand port **54** (the angle between the pivot axis **40** and longitudinal axis **45** of hose wand port **54** - see **Figs. 1** and **2**). Notice that the longitudinal axis **45** of the hose wand port **54** is the same as the longitudinal axis of hose wand **20**, which is inserted within air channel **56** of port **54**. Rotation of housing **50** with respect to housing **30** provides a ring of orientations **44**, which longitudinal axis **45** may be pivoted to. Ring **44** shows the many directions axis **45** can be directed to, with ring **44** extending into and out-of the page, except for directions **45** and **46.** Only axis positions **45** and **46** in **Fig. 1** lay within the plane of the page, the remaining directions all have a **y-axis** component to their direction. The nozzle's longitudinal axis **45** is near the **x-axis** in position **46,** seen in **Fig. 1**, is shown oriented this way in **Figs. 2 and** 4). When hose wand port **54** is in position **45**, as seen in **Fig. 1** and **3**, hose wand **20** is at a maximum angle θ_3 with the surface to be cleaned **68** (**x-y** plane). At this maximum angle position (shown in **Figs. 1** and **3**), maximum angle θ_3 is equal to angle θ_1 plus angle θ_2. At hose wand port axis alternate position **46**, as seen in **Fig. 1** (see axis 45 in **Figs. 2**), upper housing **50** has been rotated around pivot axis **40** approximately 180 degrees from the position seen in **Fig. 1**. When hose wand port **54** is in position **45** in **Figs. 2** and **4**, hose wand **20** is at an minimum angle θ_4 with the surface to be cleaned (**x-y** plane). At this minimum angle position (shown in **Figs. 2** and **4**), minimum angle θ_4 is equal to angle θ_1 minus angle θ_2. Note that choosing different angles for θ_1 and θ_2 (see **Figs. 5** through **7**) can result in a different final maximum angle θ_3 and minimum angle θ_4 for hose wand **20**.

For orientations between the positions seen in **Figs. 1** and **2,** the hose wand port **54** changes between these two values. Notice that hose wand **20** does not stay in the **x-z** plane during this transition except at the two positions shown. At all other positions the hose wand will have a component in the "y" direction (**y-axis**), that is, coming in or out of the paper in **Figs. 1** through **4** (see position ring **44** in **Fig. 1**). Many different ranges of angles for the the

hose wand angle changes may be designed into the pivotal nozzle body by changing the values of θ_1 and θ_2 (see **Fig. 5**). Also, if the pivot axis **40** is given a **y-axis** component (that is, its axis no longer lies on the page in **Figs. 1** through **4**), then more complicated changes in the direction of hose wand port **56** may be achieved. The variation is nearly endless, and can provide the specific angle changes desired for specific cleaning needs as the user pivots upper housing **50** with respect to lower housing **30.**

In **Figs. 5** through **7,** we see an alternative pivot nozzle with upper housing **150** and lower housing **130**. This pivotal nozzle body (housings **130** and **150**) can be designed for attachment of similar tools seen on pivot nozzle seen in **Figs. 1** through **4**. Lower housing **130** comprises a angled tube shaped body section **132** with a air channel **136** passing through it. At the tool end of body **132** are attached a pair of arms **160** with brush strips **162** along its contact surface. On the pivot end of body section **132** is molded a pivot ring **137** which engages pivot tube **157** on housing **150.** Ring **137** and tube **157** define a pivot joint with a pivot axis **140.** As with pivot axis **40** in **Figs. 1** through **4,** pivot axis **140** lays within the **x-z** plane, but can easily be designed to have a **y-axis** component if desired. Upper housing **150** comprises a pivot port defined by tube **157** at one end and a hose wand port **154** at the other end, with an air passageway **156** formed between tube **157** and port **154.** A brush skirt **152** is included here as a brush cleaning tool holder with a forward end **175** and a rearward end **174.** Dust brush **170** with molded plastic support **172** is attached to upper housing **150** by brush skirt **152.** Port **154** is designed for removable attachment of vacuum hose **20** to provide suction air to cleaning arms **160.** Air passageway port **136** is designed for removable attachment of vacuum hose **20** to provide suction air to cleaning brush **170.** While the hose wand needs to be able to be removably attachable to both ends of the disclosed pivotal nozzle body, the tools can be molded into the nozzle housings permanently. The pivotal nozzle body, however, can be designed to allow removable attachment of different vacuum tools on one or both ends of the pivotal nozzle body. Removal can be to replace worn cleaning tools (i.e. dust brush bristles, bristle strips on arms, etc.) or to provide additional functions with different attachments. For example, for the pivot nozzle in **Figs. 5** through **7**, dust brush **170** can be snapped out of tool skirt **152** and another tool can be snapped into place (i.e. wider dust brush, special crevice tool, special floor tool, etc.). Similarly, arms **160** can be designed to easily be removed so that other arms or other

tools can be snapped into place.

In **Figs. 5** through **7**, axis angles θ_5 and θ_6 are defined (like axis angles θ_1 and θ_2) by the structure of nozzle housings **130** and **150**, respectfully. Lower housing **130** defines angle θ_5 as generally the minimum angle between the rotational axis of second pivot end **137** and the plane defined by cleaning brush strips **162** (**x-y** plane, measured from the positive **x-axis** in drawings). Angle θ_5 can also be thought of as the angle between pivot axis **140** and the longitudinal axis of hose wand port **136** (negative **z-axis**) minus ninety degrees. Upper body housing **150** defines angle θ_6 as the angle between the axis of first pivot end **157** and the longitudinal axis **145** of hose wand port **154** (the angle between the pivot axis **140** and longitudinal axis **145** of hose wand port **54** - see **Fig. 5**).

In **Fig. 5**, upper housing **150** can be rotated with respect to lower housing **130** to provide its minimum angle between the two housings (dust brush tip **175** pointing in the direction of surface **168**). This minimum orientation of the pivot nozzle body is shown by phantom position **20c** of hose wand **20** in **Fig. 6**, and phantom position **152c** of tool skirt **152** in **Fig. 7**. The angle The θ_5 angle is ten degrees, such that pivot axis **140** is ten degrees above the **x-y** plane, which defines the orientation of pivot axis **140** on lower housing **130**, and means pivot axis **140** is nearly parallel with the surface being cleaned **168**. The θ_6 angle is thirty-five degrees, which defines the angle difference between pivot axis **140** of pivot port **157** and longitudinal axis **145** of hose wand port **154** (same longitudinal axis as hose wand **20**). The result is a pivot nozzle body with a range of motion for hose wand **20** between positive forty-five degrees above the **x-y** plane (see phantom lines **20a** and **152a**, in **Figs. 6** and **7** respectfully), and twenty-five degrees below the **x-y** plane (see phantom lines **20c** and **152c**, in **Figs. 6** and **7**, respectfully). The pivot joint composed of ring **137** and tube **157** hold housings **130** and **150** together by the interaction of ring-shaped ridge **158** on tube **157** with the edge of pivot ring **137**. Both ring **137** and tube **157** are circular in cross section so that ring **137** can easily rotate around tube **157**. Additional bearing rings can be placed between the contacting surfaces of ring **137** and tube **157**, to control friction, wear, and/or other factors, as is common in present day vacuum nozzles.

In **Figs. 6** and **7**, we see perspective views of the pivotal nozzle body in **Fig. 5**, with the upper housing **150** pivoted about ninety degrees from its orientation shown in **Fig. 5**. Both show upper housing **150** rotated approximately half way between its maximum angle θ_7 and its

minimum angle θ_8. In **Fig. 6**, upper housing **150** is shown at 90 degrees from its maximum angle position (midway between maximum and minimum angles). Notice that at 90 degrees rotation hose wand **20** is slightly above being parallel to the **x-y** plane (approximately positive 10 degrees for the numbers chosen, $\theta_5 = 10$ degrees, $\theta_6 = 35$ degrees). If housing **150** is rotated slightly further as shown in **Fig. 7**, hose wand **20** can be parallel to the **x-y** plane as shown by shadow position **20b** in **Fig. 7**. Further rotation of hose wand **20** moves housing **150** to minimum position **152c** and **175c** (see **Figs. 5** and **7**), and hose wand **20** at position **20c** (see **Fig. 5** and **6**). Alternative orientations for upper housing **150** are shown by shadow lines. The orientation at maximum angle value θ_7 for the pivot nozzle body in **Figs. 5** through **7**, is shown by hose wand **20** in position **20a** with longitudinal axis **145a** (in **Fig. 6**), and upper housing position **152a** of tool skirt **152** (in **Fig. 7**). The orientation at minimum angle value θ_8 for the pivot nozzle in **Figs. 5** through **7**, is shown by hose wand **20** in position **20c** with longitudinal axis **145c** (in **Fig. 6**), and upper housing position **152c** of tool skirt **152** (in **Fig. 7**). The thirty-five degree angle in housing **150** ($\theta_6 = 35$ degrees) means that, in the positions shown in **Figs. 6** and **7**, the hose wand's longitudinal axis is pointing about thirty-five degrees away from the x-y plane. In **Fig. 6**, this causes the arm marked **160** to angle forward with respect to hose wand **20.** This can be used as an advantage, because the end of the forward leaning arm **160** can be used to suck up dirt and material along an edge running perpendicular to hose wand **20** (using the open end of arm **160** against a surface to function like a crevice tool. The nozzle in **Fig. 6** can be used as a full crevice tool by simply pivoting both arms **160** together so that their brush strips **162** touch (see **Fig. 7** with arms partially closed). The nozzle in **Fig. 7** can be used as a crevice tool by simply inserting hose wand **20** into upper housing **150** a position **20b** and closing arms **160** so that brush strips **162** seal against each other. Different orientations of the pivotal nozzle body can be used for the crevice tool mode to reach differently angled surfaces, with pivot joint friction maintaining the desired orientation for cleaning.

Some of the differences between housings **130** and **150**, and housings **30** and **50,** comprises changes to the pivot joint and the axis angles θ_1 and θ_2. The pivot joint in **Figs. 5** through **7**, comprises ring shaped lip **137** (first pivot end) on the lower housing **130**, and ring shaped tube **157** (second pivot end) on upper housing **150.** which are connected so that upper housing **150** can swivel with respect to lower housing **130.** Ring **137** and tube **157** in **Figs. 5**

through **7** are longer than ring **37** and tube **57** in **Figs. 1** through **4**. This can give the pivotal nozzle body greater stability from binding when forces needed to swivel the pivot joint are applied. The pivot joint is also at a different angle than in the design in **Figs. 1** through **4**. The values of angles θ_5 and θ_6 have been modified compared to axis angles θ_1 and θ_2, respectfully, to allow hose wand **20** to pivot below the **x-y** plane in its minimum angle position (angle θ_8 negative). For lower housing **30** in **Figs. 1** through **4**, θ_1 on housing **30** was approximately 25 degrees, and θ_2 on housing **50** was approximately 20 degrees. In **Figs. 5** through **7**, lower housing **130** has a θ_5 of approximately 10 degrees, and upper housing **150** has a θ_6 of approximately 35 degrees. This results in both pivot nozzle bodies to have the same maximum angle (θ_3 equal to θ_7) of approximately 45 degrees, but different minimum angles θ_4 and θ_8. The pivotal nozzle body in **Figs. 1** through **4** has a θ_4 of approximately positive 5 degrees, while the pivotal nozzle body in **Figs. 5** through **7**, has a θ_8 of approximately negative 25 degrees (a thirty degree difference). This negative angle can be used to allow cleaning of high surfaces, such as, the tops of cabinets and book shelves. This angle arrangement also allows the user to lower the hose wand parallel to the floor without having to rotate hose wand **20** around its longitudinal axis a full 180 degrees. Instead, the hose wand can be brought parallel to the floor (**x-y** plane), in upholstery mode by rotating hose wand **20** about 100 degrees from its maximum angle position (phantom positions **20a**, **152a** and **175a**).

OPERATIONAL DESCRIPTION -- Figs. 1 through 4

During use, hose wand **20** is inserted in port **56** or port **36** to provide suction air to the pivotal nozzle body disclosed in **Figs. 1** through **4.** Both channel port **56** and air channel port **36** provide a snug fit for hose wand **20** so that friction keeps the hose wand attached. Other methods can be used to hold a hose wand on the nozzle, including positive locking systems, such as, twist and lock connectors (bolt action like engagement), spring loaded buttons (button on hose or nozzle engaging a hole in the nozzle or hose respectfully), etc.

With hose wand **20** inserted into port **56** (see **Figs. 1** through **4**), suction air is provided to cleaning arms **60** for cleaning. For floor cleaning, cleaning edges **62** are placed flat against a surface to be cleaned **68** (floor, upholstery, etc. - see **Fig. 4** and **5**). Air is pulled in through channel **64** formed by arms **60** being in contact with surface **68**, through port **36**, through pivot

channel **59**, through port **56** and finally into hose wand channel **22**, which leads to a vacuum cleaner. Arms **60** on second tool end **34** can be pivoted to provide added functions, such as, allowing the folding together of the arms to create a crevice tool or separated slightly to create a gap for cleaning blinds, or the arms may also be pivoted apart to form a floor tool or an upholstery tool, or other angles for the arms. Other specialty tools may be used in place of arms **60**. Also, while arms **60** are designed to be removable from lower housing **30**, they are not designed to be easily removable by the user. In an alternative design, tool end **34** may be designed to allow the user to easily add and remove different tools from end **34** to provide multiple function. Tool end **34** can easily be modified in shape and size to meet the needed functional needs for the vacuum tools that will be attached to it. Similarly, tool end **55** may also be designed to allow multiple user attachable and removable tools. Also notice that the tools do not have to be centered around hose wand ports **36** and/or **56**. Also notice that the end of port **36** and/or port **56** may be formed into a cleaning tool by itself.

With hose wand **20** inserted into port **36**, the dust brush **70** may be used for cleaning, with suction air from hose wand **20**, pulling air from around dust brush **70** through air channel **56**, through pivot joint air channel **59**, through air channel **36**, and finally into hose wand **20**. Upper housing **50** and dust brush **70** may be rotated about pivot joint axis **40** to provide different cleaning angles for the dust brush as desired.

When the user operates the vacuum tool as a floor tool or an upholstery tool (as seen in **Figs. 1** through **4**), hose wand **20** is inserted into port **56**. Hose wand **20** fits tightly into port **56** so that rotation of hose wand **20** by the user put a rotational torque on upper housing **50**. With arms **60** extending along the **y-axis** (in-and-out of the page in **Figs. 1** through **4**), the arms resist this torque that is transmitted through the pivot joint and allows the user to rotate upper housing **50** with respect to lower housing **30**. Thus, the user may be cleaning a surface **68** with the pivotal nozzle, with contact edges **62** against the surface (see **Figs. 1 and 3**), while the user holds onto the far end of the hose wand (not seen off the page). To clean under low furniture or other low objects, the user simply twists the upper part of hose wand **20** in their hand, which turns upper housing **50** with respect to lower housing **30**. Friction between the contact surfaces at the pivot joint (contact between ring **37** and tube **57**) transmits this rotational force to lower housing **30** which resists rotating about hose wand **20** because of the extended arms **60**, which

push against surface **68**. The separated nature of arms **60** resist allowing lower housing **30** also pivoting. Thus, while front end **75** of brush connector **55** begins to move away from its upward facing orientation and rotate toward the floor while rear end **74** of brush connector **55** begins to move way from its downward facing position, cleaning edges **62** remain substantially in contact with the surface being cleaned **68.** As upper housing **50** rotates with respect to housing **30**, hose wand **20** must change its angle with respect to cleaning arms **60** to keep cleaning edges **62** in contact with surface **68.** When housing **50** has been rotated about ninety degrees from its position in **Fig. 1** hose wand **20** is angled about twenty-five degrees above the floor. At the same time, because $\theta_2 = 20$ degrees, this rotated position places hose wand **20** at an angle of about twenty degrees toward the **y-axis** (into or out-of the page - see **Fig. 6** for example).

As hose wand **20** is rotated further toward the position seen in **Fig. 2**, the hose wand can be moved closer and closer to being parallel with the floor (see **Figs. 2** and **4**) while keeping cleaning surfaces **62** in contact with surface to be cleaned **68.** Front end **75** of brush connector **55** is now pointing toward surface **68** and brush connector rear end **74** is pointing upward away from surface **68.** In this position, with hose wand **20** nearly level with the floor (approximately five degrees above the floor), the user can now get the pivotal vacuum nozzle under the low furniture for cleaning. Similarly, when the user is done cleaning under the low furniture, they can twist the hose wand back to its original position (see **Figs. 1 and 3**) to restore the hose wand to its upright cleaning position.

The operation of the pivotal nozzle body in **Fig. 5** is essentially the same as in **Figs. 1** through **4**. Only the angle range of the hose wand is changed by the selection of θ_5 and θ_6. The maximum upright angle θ_7 (obtuse angle - greater than ninety degrees)is the same as maximum upright angle θ_3 in **Figs. 1** through **4**, but the minimum angle θ_8 (acute angle - less than ninety degrees) can be much lower than the minimum angle θ_4 in **Figs. 1** through **4.** Because angle for θ_8 is a negative angle (hose wand extending below **x-y** plane), the hose wand does not need to be twisted 180 degrees to be parallel to the floor. In fact, for the choices of $\theta_5 = 10$ degrees and $\theta_6 = 35$ degrees, hose **20** would only need to be twisted about 100 degrees from its **152a** position (see **Fig. 7**) to reach parallel to the floor (**x-y** plane). Further rotation moves hose wand **20** below cleaning surface **68 (x-y** plane) as seen in **Fig. 5** to form an acute angle between longitudinal axis **145** of hose wand port **154** and the longitudinal axis of hose wand port **136**

(negative **z-axis**).

In **Fig. 7**, we see the pivot nozzle being used as a dust brush with hose wand **20** inserted into air passageway (hose wand port) **136.** Arms **160** are angles approximately as shown to allow easy insertion of hose wand **20.** The angle between tool ends is about 90 degrees (angle between hose wand **20** shown in **Fig. 7** and phantom hose wand position **20b**. This allows the cleaning portion of dust brush **70** to be parallel to the hose wand axis. Further angling of upper housing **150** to position **152c** results in an acute angle between the hose wand ports that allows cleaning high surfaces as shown in **Fig. 5** with either the upholstery tool as shown or the dust brush (see **Fig. 7**).

STABILITY DURING OPERATION

The issue of stability of the nozzle during use occurs because of the ability of the disclosed pivot nozzle to pivot around a pivot axis. If the angle of the pivot axis is not chosen correctly or if the pivot joint has to friction for stable use, the tool end of the nozzle can simply flop around on the end of the nozzle uncontrollably. For different uses, and functions, different parameters are needed. For example, for a floor or upholstery tool the pivot axis works best if it is closer than 45 degrees from the **x-axis** as defined in the drawings. While larger angles work fine for other cleaning purposes (i.e. dust brush use) placing the pivot axis near the **y-axis** and or the z-axis makes the nozzle unstable for floor and upholstery cleaning (see **Fig. 6** for example of floor and upholstery mode). This instability results from two factors. When the pivot axis is too close to the z-axis, any differential **x-axis** force on the ends of the arms can tend to spin the lower housing about the pivot axis. Similarly, if the pivot axis is too close to the **y-axis**, **x-axis** force on either arm can tend to rotate the lower housing about the pivot axis. It turns out that for floor and upholstery cleaning, the best stability and range of angle orientations is achieved with a pivot axis no more than 30 degrees from the **x-axis**. Unfortunately, this range is not necessarily very good for some other tools, namely the dust brush and arms in crevice mode, which experience **y-axis** forces during normal use. This **y-axis** force tends to rotate the tool around the pivot axis (see pivot axises **40** and **140**). This tool rotation problem, however, is easily solved by simply providing some internal friction to the pivot joint, so that during normal dusting or crevice tool use, the **y-axis** forces are not great enough to overcome the

friction within the pivot joint. This friction, however, cannot be so great that it interferes with the use of the tool in floor cleaning mode. The nozzle body should be easily pivotable by the user, when twisting on the hose wand attached to it. Luckily, the twisting force a user can place on the hose wand, and the leverage the extended arms can provide, is considerably greater than the friction needed for stable dusting or crevice tool use. Thus, the user can easily rotate the hose wand about the pivot axis and lower the hose wand to the floor to get under furniture and the like even when sufficient friction is present to allow normal dusting and crevice tool operation. The pivot joint friction may come in a number of forms, from a continuous friction force between the upper and lower housing, a notch and tab arrangement to provide specific orientations where greater friction force located, etc. or a combination of different friction methods.

RAMIFICATIONS, and SCOPE

The disclosed design for a multi-function pivotal nozzle body with a built in pivot joint allows for a very compact vacuum nozzle to be designed that provides many functions, including a floor tool that can pivot with respect to an attached hose wand. In floor mode this pivot joint allows the nozzle's cleaning surfaces to remain flush against the floor, while the hose wand can be lowered to the floor to get under low furniture. The pivot joint is also useful for cleaning high surfaces (see **Fig. 5** through **7**) because it can allow the tool ends to be pivoted to an acute angle with respect to the hose wand. This allows the tool to make contact with a high surface while the hose wand angles downward from the nozzle, thus eliminating the need for the user to get on a chair or ladder to reach the surface.

Although the above description of the invention contains many specifications, these should not be viewed as limiting the scope of the invention. Instead, the above description should be considered illustrations of some of the presently preferred embodiments of this invention. For example, many angle combinations are possible, including ones where the pivot axis does not align with the **x-z** plane as it does in **Figs. 1** through **7.**

If we consider θ_1 and θ_2 variables then the pivotal nozzle body in **Figs.1** through **4** can be modified by simply changing the values of θ_1 and θ_2. For example, pivot axis that aligns with the x-axis would have a θ_1 equal to zero degrees on housing **30**, while housing **50** may

have a θ_2 equal to forty-five degrees so that hose wand **20** can have the same maximum angle θ_3 equal to forty-five degrees. Notice though that with this angles ($\theta_1 = 0$ degrees, and $\theta_2 = 45$ degrees) the hose wand can be rotated to negative forty-five degree angle below the **x-y** plane. Notice that angle θ_1 itself can be negative (pivot axis pointing below the **x-y** plane), which would provide extreme angle changes when hose wand **20** is rotated. However, a negative θ_1 would create a somewhat "S" shaped suction passageway through the pivot nozzle, which could restrict air flow. The combinations are nearly endless. Also, many ways exist to construct a pivot joint between the upper and lower housings. Many suction conduit pivot or swivel joints exist in prior art and most can be used in this application. Thus, the pivot joints shown are certainly not the extent of possible and known ways to construct a pivot joints for the disclosed pivotal nozzle body. The addition of other bearing rings or structures in the pivot joint are commonly used in the vacuum industry to control deformation of the softer nozzle housing materials, and/or to control friction within the joint. Finally, the basic pivotal nozzle body can be used as a general purpose pivot adaptor for connecting different sized tools and different sized hose wands on each end of the pivot nozzle body. The interior/exterior hose wand port design shown in prior art **U.S. Patent No. 6,581,974** can also be used with this pivot nozzle body to provide cross platform functionality.

Thus, the scope of this invention should not be limited to the above examples but should be determined from the following claims.